Marine Debris Project Presentation Video Transcript

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Hello, this is the NASA DEVELOP team located at Stennis Space Center, and this is the first part of a two part project using radar altimeter data to monitor the Gulf of Mexico Loop Current and analyze how surface circulation patterns affect marine debris dispersal.

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Each DEVELOP project focuses on finding ways to use NASA satellite observations to address community concerns. This project focused on studying the circulation of marine debris in the Gulf of Mexico and how this debris is impacting Padre Island National Seashore. Through their research, the students found several community concerns important to the island and the National Seashore there. First, ecotourism is the fastest growing segment of the Texas gulf coast's tourism-based economy, according to a report put out in 2009 by the Corpus Christi Convention Center and Visitor's Bureau. In the same report, it was noted that within the coastal bend area of Texas, ecotourism employs over 8,748 citizens and provides approximately $233.5 million dollars in household earnings. It is important to study marine debris and how it impacts the island because any decrease in ecotourism could come with a subsequent decrease in earnings and employment opportunities. Beyond financial reasons, however, it is also important to study Padre Island National Seashore because it is a critical part of the Central Flyway, which is a major migratory route for 380 species of migratory birds, 13 of which are threatened endangered according to the National Park Service. Additionally, Padre Island National Seashore is one of two global nesting sites for the endangered Kemp's Ridley Sea Turtle, according to a National Park Service report written by Donna Shaver in 1989. For these numerous reasons, it is important that we understand how marine debris is being circulated in the Gulf of Mexico and how this debris washes on the shore of Padre Island and is impacting the habitat and also, ecotourism opportunities for the island.

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Our partners and collaborators for this project include Neal Parry, the Gulf of Mexico Regional Coordinator for NOAA's Marine Debris Program; William Botts, Education Coordinator for Padre Island National Seashore; the National Park Service; the University of Colorado Boulder; and the University of Colorado Center for Astrodynamics Research. Our science advisors for this project were Joe Spruce, with CSC located at Stennis Space Center, and Dr. Robert Leben, professor at the University of Colorado and researcher with the Center for Astrodynamics Research.

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To determine the best course of action for the project, students met with members of NOAA's Marine Debris Program to determine the best way that the project could enhance the efforts that were already underway at NOAA. It was determined that two different goals would be ideal results to the project. The first goal would be for animations that would convey sources and mechanisms of how marine debris is being dispersed in the Gulf of Mexico. The second goal that would enhance what is already being done at NOAA, would be to create an improved method for monitoring the loop current in the Gulf of Mexico, as well as predicting the path of marine debris trajectories and particle transport. Every project that DEVELOP conducts addresses one or more Applications of National Priority, as outlined by NASA's Applied Sciences Program. The particular applications addressed by this project are Public Health, Ecological Forecasting, and Water Resources. Some of the example outputs of the altimetry that was processed to show loop current, as well as the outputs of the MASE Wave Model, are shown on the right hand side of the screen.

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The study area for this project is the Gulf of Mexico and Padre Island, Texas, seen here in this ASTER image from 2009.

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This slide shows a general land cover map of Padre Island, Texas, produced from Landsat imagery acquired on June 10, 2010. This map will be used by our partners, the Padre Island National Seashore, in order to gain a better understanding of the types of habitats located on Padre Island and how they may be affected by marine debris.

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This project used Sea Surface Temperature data collected by the MODIS sensor onboard *Aqua* and *Terra*. Sea Surface Temperature data was subset and converted from HDF format in ERDAS Imagine to be used in a time series visualization. The daily Sea Surface Height data provided by the Colorado Center for Astrodynamics Research utilized several altimeter sensors, including Jason1, Jason2, Topex/Poseidon, ERS 1, ERS 2 and Envisat.

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The Colorado Center for Astrodynamics Research provided daily Sea Surface Height for our study time, 2008-2010. This data was processed in Matlab to calculate geostrophic flow and predict particle paths. The Matlab program first calculates geostrophic flow. Geostrophic flow is calculated as the balance of the

horizontal pressure gradient and the Coriolis Force. The equations used to calculate geostophic flow assume the flow has no acceleration, the horizontal velocities are much larger than the vertical velocities, the only external force is gravity, and friction is small. After Matlab uses this equation to calculate surface velocity, the Quiver Command creates a vector field showing flow directions. After Matlab calculates geostrophic flow and predicts particle paths, to do this the Matlab program uses geostrophic flow and uses a numerical integration method to integrate space and time.

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This map is an output of the Matlab program showing a particle path. The sea surface currents are shown by a color scale ranging from 0-2 meters/second. The vector field on the map shows flow direction. Because Euler's Method was used to calculate the particle path, this map shows the particle exiting the eddy and entering into the Gulf Stream. This does not happen in reality, and in reality the particle would remain in the eddy.

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Because of the warm waters of the loop current, the current can be monitored using MODIS Sea Surface Temperature data. Seen here are 4 weekly composite MODIS Sea Surface Temperature images, dated November 17-24, 2009, January 17-24, 2010, April 23-30, 2010 and June 10-17, 2010. Note between the November and January images, the Loop Current has extended northward into the central Gulf of Mexico. By April, the current has begun to lose stability, and an eddy is beginning to form. By June 10, the ambient temperature in the Gulf of Mexico has become warm enough to obscure the loop current. MOSID Sea Surface Temperature Data is not useful for monitoring the Loop Current during the summer months.

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In summary, the results of this project include time series visualizations of MODIS Sea Surface Temperature data, an updated methodology for altimeter data processing, time series and maps showing Sea Surface Height for the Gulf of Mexico, maps of geostrophic velocities, and particle path predictions.

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After concluding Phase One of this project, the team concluded that satellite altimeter data is very useful in calculating Sea Surface Height, geostrophic velocity, and predicting particle paths. We also concluded that Euler's numerical integration method is a less complex method for calculating particle paths. According to partners at the University of Colorado with the Colorado Center for Astrodynamics Research, using the Runge-Kutta method would improve

accuracy. We also concluded that MODIS Sea Surface Temperature data can be used to monitor the Gulf Loop Current in cooler months but is not useful in the warmer summer months. Limitations for this project include that the Gulf current is not the only force distributing debris throughout the Gulf; prevailing wind patterns and long shore transport influence debris dispersal as well.

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Work on this project will be continued during the summer 2011 term. During the summer, the team will complete the following tasks:

- Collect and analyze data showing marine debris accumulation rates along Gulf of Mexico coastlines.
- Attempt to identify point sources of marine debris is the Gulf of Mexico by incorporating data from a 1994 study conducted by the Minerals Management Service.
- Due to inaccuracies that resulted from the use of Euler's numerical integration technique, the team will attempt to use the Runge-Kutta numerical integration method to calculate particle paths in order to improve product accuracy.
- The team will also analyze marine debris accumulation patterns that result from the Gulf of Mexico Loop Current and surface circulation patterns using methodology developed during the spring 2011 term.
- Ultimately, the team will provide enhanced maps, visualizations, and methodology to project partners in order to aid in their decision making process and outreach and community education programs.

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The DEVELOP team at the Stennis Space Center would like to thank Joe Spruce, Dr. Robert Leben, Neal Parry, William Botts, Gabriel LoDolce, Cheri Miller, Brandie Mitchell, and Jason Jones.

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That concludes our presentation. Thank you for listening.